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[0001] INTER-CELLULAR INTERFERENCE CANCELLATION

[0002] FIELD OF INVENTION

[0003] This invention generally relates to wireless communication systems. In particular, the invention relates to cross cell interference reduction in such systems.

[0004] BACKGROUND

[0005] Cross cell interference is a problem in wireless communication systems. Figure 1 is an illustration of cross cell interference. As illustrated, a wireless transmit/receive unit (WTRU) 24_1 is located at the periphery of cell 1 26_1 and another WTRU 24_2 is located near that WTRU 24_1 at the periphery of another cell, cell 2 26_2. The WTRU 24_1 of cell 1 26_1 transmits an uplink communication U1 to its base station 20_1 and the WTRU 24_2 of cell 2 26_2 is receiving a downlink communication, D2, from its base station 20_2. If the uplink communication U1 and the downlink communication D2 are sent in the same spectrum and at the same time, the uplink communication U1 interferes with the downlink communication D2's reception. Typically, to overcome the interference in its downlink communications, the WTRU 24_2 will request an increase in transmission power from its base station 20_2. The increase in transmission power results in increased interference to other WTRUs in and outside its cell 26_2.

[0006] An alternative method of link adaptation is adaptive modulation and coding (AM&C), in which coding and modulation are adjusted to reduce the information data rate in the presence of inter-cellular interference. AM&C decreases the data throughput in the affected WTRU.

[0007] In many wireless communication systems, techniques for reducing interference within a cell are employed. Some of these approaches include successive interference cancellers (SICs), parallel interference cancellers (PICs) and multi-user

detectors (MUDs). Although these techniques are effective at canceling the intra-cell interference, they treat inter-cell interference as noise.

[0008] Accordingly, it is desirable to reduce inter-cell interference.

[0009] SUMMARY

[0010] With respect to a first wireless transmit/receive unit (WTRU), at least one WTRU near the periphery of other cells is determined. Out of the at least one WTRU near the periphery, at least one WTRU nearby that WTRU is determined. The first WTRU codes are provided of the at least one nearby WTRU. A contribution of the at least one nearby WTRU is canceled from a received signal at a first WTRU, producing an interference canceled signal. Data of the first WTRU is detected from the interference canceled signal.

[0011] BRIEF DESCRIPTION OF THE DRAWING(S)

[0012] Figure 1 is an illustration of inter-cellular interference.

[0013] Figure 2 is a flow chart of inter-cellular interference cancellation.

[0014] Figure 3 is a simplified diagram of an embodiment of an inter-cellular interference canceller.

[0015] Figures 4 and 5 are embodiments of the inter-cellular interference cancellation receiving circuitry.

[0016] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0017] Although the preferred embodiments are described in conjunction with a code division multiple access communication system, the embodiments are applicable to other wireless communication systems where there is an overlap in the used spectrum between cells. Hereafter, a WTRU 24 includes but is not limited to a user equipment, mobile station, fixed or mobile subscriber unit, pager, or any other type of device capable of operating in a wireless environment. When referred to hereafter, a

base station 20 includes but is not limited to a base station, Node-B, site controller, access point or other interfacing device in a wireless environment.

[0018] Figure 2 is a flow chart for inter-cellular interference cancellation and Figure 3 is a simplified diagram of an embodiment of such a system. Typically, inter-cellular interference cancellation is performed when a WTRU 24 is experiencing high levels of interference, although inter-cellular interference can be employed at lower interference levels as well. One implementation may be in a slotted code division multiple access communication system. In a particular time slot, a WTRU 24 may experience high interference levels and in others it may experience low interference levels. In such a scenario, the high interference in one slot may result from a nearby WTRU 24 in another cell transmitting during that slot.

[0019] Initially, WTRUs located at the periphery of cells are determined, step 30. One technique for determining the WTRUs at the cell periphery is by monitoring the power level of the WTRU connections. The WTRUs with the highest transmission power levels are most likely at the periphery of the cell. Also, the pathloss for each WTRU may be used. WTRUs experiencing more losses are more likely to be at the periphery of the cell. Additionally, for WTRUs having geolocation capabilities, such as cellular based or global positioning based systems the location information along with a map of the cells is used to determine WTRUs at the cell periphery.

[0020] For a WTRU 24 at the cell periphery, a nearby WTRU or nearby WTRUs in neighboring cells are determined, step 32. One approach to determining nearby WTRUs uses geographic information. For systems using geolocation, WTRUs in close proximity can be determined by comparing their relative positions. In other systems, the sector that each WTRU resides in may be used to determine nearby WTRUs. To illustrate, WTRUs identified to be at the periphery of abutting sectors may interfere with each other.

[0021] Another approach uses interference measurements. If a WTRU 24 is experiencing high interference levels in a certain frequency or combination assigned

frequency/time slot, WTRUs transmitting in that assigned frequency or assigned frequency/time slot are identified. Additionally, received signal strength measurements, such as received signal code power (RSCP), can be used to identify nearby cells. In one embodiment, only WTRUs from the cell having the highest RSCP measurement are considered, although in other embodiments a group of cells having high RSCP values may be used. Additionally, a combination of these approaches may be used to determine nearby WTRUs.

[0022] After identifying the interfering WTRU or WTRUs, the codes used by those WTRUs are listed, step 34. For implementation with a proposed third generation partnership project (3GPP) wideband code division multiple access (W-CDMA) communication system, the listed codes would include both a scrambling and channelization code. The listed codes are signaled to the WTRU. Using these codes, the WTRU cancels the nearby WTRU signal from its received signals, step 36. Using the interference cancelled signal, the WTRU performs a data detection to recover its data, step 38.

[0023] By canceling interference from nearby WTRUs, the downlink transmission power level to that WTRU 24 can be kept at a lower power level. As a result, interference to other WTRUs is decreased, increasing the overall capacity of the system.

[0024] In Figure 3, the base station 20/wireless network 28 receives and transmits signals over the air interface 54. A measurement collection device 48 collects measurements taken by the base station 20 and WTRUs 24, such as pathloss, received signal power measurements and interference measurements. The measurements are sent to a radio resource management device 40. An interfering WTRU(s) determining device 44 uses the collected measurements to determine nearby WTRU(s). An interfering WTRU(s) code listing device 46, lists the codes of the nearby WTRUs. A WTRU(s) code signaling device 50 signals these codes to the WTRU 56. A downlink transmitter 51 transmits downlink signals to the WTRU 24 using the antenna 52.

[0025] An antenna 56 at the WTRU 24 receives the downlink signals, the interfering WTRU codes and interfering signals. A sampling device 58 samples the received signals producing a received vector, $\underline{r}$. A signal receiver 62 recovers the interfering codes, C_I. An interfering WTRU(s) canceller cancels the contribution of the interfering WTRU(s) from the received vector, $\underline{r}$, producing $\underline{r}'$. Using the interference cancelled vector, $\underline{r}'$, a data detector 64 recovers the data, $\underline{d}$, for that WTRU 24.

[0026] Figures 4 and 5 are two embodiments of interference canceling receiving circuits at the WTRU 24. In Figure 4, signals are received by an antenna 66 and a sampling device 68 samples the received signals producing a received vector, $\underline{r}$. A root mean square (RMS) value of the energy of the received signals is measured by an RMS measuring device 74. A code of the interfering WTRU(s), produced by an interfering WTRU code generator 70, is weighted by a weighting device 78 by a value derived from the RMS value, analogous to a Widrow filter. Weights could also be estimated based on known locations. The weighted WTRU code is subtracted by a subtractor 72 from the received vector $\underline{r}$, producing a vector, $\underline{r}'$, having the contribution of the interfering WTRU removed. In the case of Widrow adaptive noise cancellation, the weight is adaptively selected that minimizes the RMS output r' from the RMS measuring device 74.. A data detection using a data detector 76, such as a matched filter, SIC, PIC or MUD, is performed on the interference cancelled vector, $\underline{r}'$, producing a data vector, $\underline{d}$.

[0027] In Figure 5, signals are received and sampled by an antenna 80 and a sampling device 82, producing a received vector $\underline{r}$. Using the code(s), C_I, of the interfering WTRU(s), a joint detection is performed by a joint detector 84 to produce data of the interfering WTRU(s), $\underline{d}_I$. An interference reconstruction device 86 reconstructs the contribution, $\underline{r}_I$, of that/those WTRU(s) to the received vector, $\underline{r}$. The contribution $\underline{r}_I$ is subtracted from the received vector, $\underline{r}$, by a subtractor 88, producing an interference canceled vector, $\underline{r}'$. A joint detector 90 detects the WTRU data, $\underline{d}$.

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